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Report of the

FAO/AUSTRALIA WORKSHOP ON THE MANAGEMENT OF PENAEID SHRIMP/PRAWNS IN THE ASIA-PACIFIC REGION

Kooralbyn Valley, Queensland, Australia
29 October to 2 November 1984

FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS

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PREPARATION OF THIS DOCUMENT

This is the report of the Workshop on the Management of Penaeid Shrimp/Prawns in the Asia-Pacific Region held in Kooralbyn Valley, Queensland, Australia, from 29 October to 2 November 1984. The Workshop was hosted by the Government of Australia (the Commonwealth Scientific and Industrial Research Organization (CSIRO), Division of Fisheries Research, Cleveland, Queensland; and the Department of Primary Industry, Fisheries Division, Canberra) in collaboration with FAO under the FAO/Norway Cooperative Programme. The Workshop was held immediately after the Second Australian National Prawn Seminar and was a follow-up to an earlier Workshop on the Scientific Basis for the Management of Penaeid Shrimps, which was held in Key West, Florida, USA, in November 1981. For further information, readers should refer to the papers presented at the Second Australian National Prawn Seminar (to be published by CSIRO, Queensland, Australia) and the publication edited by Dr. J.A. Gulland and Dr. B.J. Rothschild, 1984, Penaeid shrimps - their biology and management. Selected papers presented at the Workshop on the Scientific basis for the management of penaeid shrimp held at Key West, Florida, November 1981. Sponsored by the US Department of Commerce, NOAA/NMFS Southeast Fisheries Center, Miami, Florida, and the Gulf States Marine Fisheries Commission, Ocean Springs, Mississippi, in collaboration with FAO of the UN, Fishery Resources and Environmental Division, Rome, Italy. Farnham, Surrey, England, Fishing News Books Ltd., 308 p.

ABSTRACT

Tropical shrimp fisheries cause management problems in many regions of the world. The experiences within the Asia-Pacific region are reviewed from seven aspects: a) the dynamics of shrimp stocks; b) the interaction with other species; c) controls on size of capture; d) controls on fishing effort; (e) allocation: f) data/information; and g) economics and trade. Most significant is the increase in value of shrimp fisheries that can be obtained from controls that increase the size of shrimp at capture.

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INTRODUCTION

Management problems occur in tropical shrimp fisheries in many regions of the world. These problems are highly diverse and include some of the following: problems caused by sudden declines in resource abundance; conflicts caused by shrimp trawlers intercepting other fishermen's catches of fin-fish; competition with other fishermen over fishing areas; competition between fishermen for the resource, particularly the capture of juveniles (either by artisanal fishermen or for culture); sharing of common shrimp resources by several countries, particularly where one country provides the habitat for producing and rearing fry which recruit to the fishery as adults in another country; limiting the number of trawlers to maximize revenues; the loss in potential revenues from less than optimal size of shrimp at capture; the difficulty in increasing the size of fin-fish captured by trawling because of the necessity of using small mesh sizes to harvest a percentage of shrimp in order to make fishing economically viable; and difficulties in effective market penetration.

These problems as they relate to the Asia-Pacific region were discussed at a Workshop held in Kooralbyn, Queensland, Australia, from 29 October to 2 November 1984. The Workshop was intended to follow, but not repeat, the FAO/US NMFS Workshop on "The Scientific Basis for the Management of Penaeid Shrimp" held in Key West, Florida, in November 1981. The Kooralbyn Workshop was attended by 39 participants from nine countries and two international agencies. A list of those attending is given in Appendix 1.

The participants were welcomed by Dr. Robert Bain on behalf of the Australian Minister for Primary Industry, and by Dr. Chris Newton on behalf of the Food and Agriculture Organization of the United Nations. The Workshop was under the general chairmanship of Mr. Bernard Bowen of the West Australian Department of Fisheries and Wildlife. A useful background to the Workshop was provided by the Second Australian National Prawn Seminar which was held in the week preceding the Workshop. The proceedings of that Seminar will be published in 1985 and enquiries about them should be addressed to CSIRO.

The Workshop discussions were arranged under seven topics. Each topic was introduced by a technical secretary and discussions proceeded under the chairman appointed for that topic. The topics with the chairmen and technical secretaries were:-

(a) Dynamics of shrimp stocks
Chairman B.K. Bowen, Technical Secretary S. M. Garcia

(b) Interaction with other species
Chairman K. L. Ch'ng, Technical Secretary S. Nichol

(c) Controls on size at capture
Chairman D. A. Hancock, Technical Secretary W. Dall

(d) Controls on fishing effort
Chairman J. Lock, Technical Secretary J. W. Penn

(e) Allocation of shrimp resources
Chairman G. R. Morgan, Technical Secretary C. H. Newton

(f) Data/Information
Chairman S. M. Garcia, Technical Secretary D. J. Staples

(g) Economics and trade
Chairman R. Bain, Technical Secretary B. J. Scott.

The following served as Rapporteurs: R. K. Lewis, N. P. Van Zalinge, R. J. Slack-Smith, S. M. Garcia, G. R. Morgan, D. Grey, D. Num, A. Sribhibhadh, and C. H. Newton.

The Australian organizing committee was B. J. Hill, D. J. Staples, P. C. Rothlisberg, R. Middlemann, and E. D. Wallis.

The report of the Workshop is given under the seven headings in the following pages. The term shrimp has been used to cover all sizes of penaeid shrimps and prawns.

DYNAMICS OF SHRIMP STOCKS

In assessing the effectiveness of research to determine the dynamics of shrimp stocks it is important to differentiate between the various broad categories of shrimp fisheries. It was apparent that the level of research carried out, the collection of fisheries derived data, the degree of sophistication of analysis and the use of the results are dependent on the size of the fishery in both participation, spatial distribution and the socio-economic and political constraints of the fishery.

The major broad distinctions are:

- high technology industrial fisheries (e.g. Australia and America);
- medium technology industrial fisheries (e.g. Pakistan);
- artisanal fisheries.

Stock assessment models available include:

- Production models based on Schaefer's original model. These models, using fisheries derived data, have value as they provide an estimate of the average expected catch and describe the behaviour of the fishery. These models are limited by having an inadequate biological basis, by difficulties in standardizing effort, variations in catchability, and biological variability. They can be used to define long-term objectives but cannot be used for short-term predictions.

- Yield per recruit models. These are useful for short- and long-term estimation but caution is required in their application because of their sensitivity to the various input parameters, particularly the estimate of natural mortality (M). In developing countries these models can be particularly useful in the analysis of the bio-economic interactions between artisanal and industrial sectors of the fishery. However, the potential effect of fishing on recruitment is disregarded in these models. The lack of basic research on growth and mortality in developing countries may be overcome to some extent by using values obtained for similar species in other areas.

- Spawning stock/recruitment relationships. Following recent evidence of recruitment overfishing in some shrimp fisheries such as the Australian Exmouth Gulf fishery, there is a clear requirement for more research into stock recruitment relationships.

- Length frequency analysis. This type of analysis will play a greater role in the future. The techniques are improving but major difficulties occur in the quality of the sampling programmes. Commercial categories (size gradings) are of value although they are difficult to work with. Increased effort in this area is recommended especially in the area of sex and species discrimination.

- Forecasting models. In Australia, two types of forecasting models are currently used. The first type of model is used to provide predictions on the optimal timing of fishing to maximize yield. It is based on a knowledge of population parameters and depends upon synoptic surveys, carried out with assistance from industry. The second type uses environmental variables (e.g. rainfall and temperature) together with life history parameters to forecast the extent of recruitment and catch. These activities are supported by industry as being of direct economic value because they enable timely and cost-effective dispersal of the fleet even though lead times range from only one to six weeks. In other countries, several forecasting models which relate annual catch to environmental parameters (e.g. rainfall, temperature) have been developed. The models are used to a limited degree in the USA but further development and testing is still required.

The effectiveness and precision of the various models is highly variable depending on the level of sophistication of the fishery, the resources available for data collection and parameter estimation and the socio-political constraints of particular countries. Due to the absence of adequate data-bases, and the low probability of collecting them, in most Asia-Pacific region shrimp fisheries there is a need for simple models not requiring sophisticated parameter estimation. However, the more simple the model the lower the degree of precision attainable. This constraint may be acceptable if less sophisticated fisheries are able to cope with higher degrees of uncertainty.

Although no single predictive model is suited to all areas, the identification of shrimp species groupings with similar environmental requirements and life history strategies, along with the continuation and refinement of the studies being undertaken in the developed fisheries countries, could be used to improve predictions in the less developed countries. There is a need for improved understanding of basic life histories and the influence of variable environmental factors. This is particularly important when multi-species stocks, with varying recruitment, mortalities and habitat requirements between species, are exploited. Such exploitation has the potential to significantly alter population structure and to threaten species in addition to the major target species.

In recent years there has been some supporting evidence that recruitment overfishing can occur. There is however difficulty in separating the effects of fishing from those of the environment. The components of environment and fishing pressure are not independent and the impact on a stock of a major environmental perturbation may be more severe as fishing pressure increases.

The Australian and Gulf of Mexico experiences have shown that the application of fishery research and the introduction of management measures deriving from this research has been cost-effective through significant increases in the value of production, particularly in smaller or well delineated fisheries with high resolution data bases. This experience has shown that, although management decisions may be justified on economic grounds, decisions must take into account the biological characteristics of exploited species.

Summary

1. Stock production models, despite recognized limitations, have a useful role in management.

2. Yield per recruit models are valuable, but highly sensitive to parameter inputs. Natural mortality (M) continues to be poorly quantified.

3. Managers need to be aware that recruitment overfishing can occur in shrimp fisheries. Critical situations and vulnerable species need to be identified.

4. Short-term forecasting models based on strategic sampling, particularly pre-season, have been supported by industry as highly cost-effective.

5. Models based on environmental parameters, and including provision for a stock/recruitment relationship, have the potential for long-term description of a fishery.

INTERACTION WITH OTHER SPECIES

Several considerations are important in deciding whether bycatch avoidance, retention, or discard should be a management goal in a shrimp fishery. Consideration must be given to whether the bycatch is needed as a protein source, or whether the species and size composition of bycatch holds any potential for economic utilization. Biological concerns include possible declines in numbers or average size of fin-fish, and changes in species composition resulting from shrimp trawling; any evidence of stock/recruitment changes in the bycatch species; the effects of bycatch species on shrimp predation and the role of the bycatch biomass (alive, dead, or removed) on the marine ecosystem.

Information supplied to the meeting showed that the volume of bycatch from shrimp trawling is high; Thailand at least 500,000 t (for reduction only); Indonesia 200,000 t; Malaysia approx. 170,000 t; Northern Australia 120,000 t; Papua New Guinea 11,000 t. The proportion of shrimp in the total catch was reported to vary between 7 percent and 40 percent, with the average percentage being in the vicinity of 10 percent. The shrimp to bycatch value ratio was reported to be as high as 100:1.

In several countries bycatch is not retained, however, primarily for economic reasons. Some countries have difficulties in marketing the shrimp bycatch due to the large diversity of the fish species encountered. Indonesia has problems with its Arafura Sea shrimp fishery, where distances to areas of high population are too large to make transport economic.

In the USA bycatch is largely discarded for economic reasons. Limited capacity for rapid freezing of large fin-fish bycatches restricts their retention in Bangladesh, Pakistan and parts of Australia.

Other countries make use of the shrimp bycatch. In Thailand the majority of the bycatch is utilized for food or fish meal production. In fact, the role is nearly reversed with shrimp being regarded as a highly appreciated bycatch. This situation occurs also in Burma and Nigeria. In Pakistan part of the bycatch is used for fish meal. A limited scale system of carrier boats buying the bycatch at sea has developed on fishing grounds that are not too far from the processing centre. Australia reported increasing usage of higher value components such as squid and slipper lobster.

Changes in species composition in shrimp bycatch have been reported from the Yellow Sea, Gulf of Thailand, West Africa and the Gulf of Carpentaria in Australia. Changes were not evident in Burma or the Gulf of Mexico. In the Gulf of Thailand and West Africa the squid population increased as other fish species declined in abundance. In a study carried out in Australia it was reported that approximately 30 percent of the discarded dead fish from shrimp trawling operations float and are eaten by birds and dolphins. Crabs and other crustaceans are usually returned to the water alive. A comparative study exploring why species composition has changed in some areas but not in others is warranted. Very little research beyond creation of conceptual models has been conducted. Many fish taken are too small to be predators on shrimp and thus there is some doubt that their elimination would be an important factor in changing shrimp natural mortality (M). However, in many areas the bycatch species are so abundant that even infrequent ingestion of shrimp by individual fish could produce a major component of shrimp natural mortality. Several examples of abundance changes exactly the opposite of what would be predicted by two species models have been reported. Stock/recruitment relationships could be operating and changes in size composition may affect fisheries.

Trials on net modifications to allow escapement of bycatch have been undertaken by both Indonesia and the USA. Tests in the USA of light-weight and collapsible Trawl/ Efficiency Devices (TEDs) (originally designed to exclude turtles) reduced bycatch by 50 to 75 percent. Indonesian tests on similar devices showed reductions of between 18 and 64 percent in fin-fish catches.

In situations where bycatch retention is the management option which is selected, there is a need for further investigations:

(a) Increased use of fish silage for shrimp food in aquaculture and for the production of surimi, fish cakes and fish balls for the Asian market should be explored.

(b) Bycatch marketing studies should be undertaken, and gear and vessel modifications that allow specific retention of bycatch should be investigated.

(c) Impacts of landings by the shrimp fleet of large fin-fish bycatches in competition with existing commercial or artisanal fin-fisheries must be considered.

Summary

1. Shrimp freezer trawlers will have to be redesigned if they are to accommodate the increased carrying capacity necessary for the low price/high volume characteristics of bycatch.

2. Fishing gear can be modified to avoid unwanted species.

3. Market development of bycatch species may improve the price of the bycatch, particularly for production of minced fish products which will not affect the price of artisanal fish landings.

4. Development of simple onboard methods for production of fish silage could result in bycatch being used as food for aquaculture.

ALLOCATION OF SHRIMP RESOURCES

In considering the question of allocation of shrimp resources it is appropriate to consider specific situations at three levels. The first is allocation of resources between nations which, by virtue of their geographic proximity and the distribution of the species, share a common resource and both expect access to that resource. The second is where resources are to be allocated between states/territories/communities within a single nation. The third is the allocation of a resource to user groups within one state/territory/community. These user groups can include artisanal or small-scale fishermen sharing with industrial fisheries, or fishermen sharing with non-fishing groups, or recreational sharing with commercial fishermen. This need for allocation often arises through inshore and offshore exploitation of one stock and/or through use of different gear in one area or for different purposes.

Within the three broad categories there are four principal topics which need to be addressed; these are:

- the groups between which the resources are to be allocated;
- the generalizations which can be made regarding the optimal allocation of the resource;
- the mechanisms available for the allocation of the resource;
- the biological, social and economic implications of the resource allocation.

The broad objectives of the allocation of common shrimp resources are stock maintenance, economic health and social equity. It is not appropriate here to provide more specific objectives as they will necessarily vary with the situation according to the nation, the stock and the nature of the competing user groups.

Examples of resource allocation between neighbouring nations cover a range of attitudes, from independent exploitation of common stocks with no agreed joint management or allocation by adjacent nations through agreed treaty arrangements to situations where exploitation is confined to inshore waters and national boundaries provided sufficient demarcation. In some situations the need for shrimp resource allocation is not recognized due to the poor data base in the countries concerned.

Resource allocation is not necessary in all situations, e.g. where adjoining nations exploit inshore stocks at the artisanal level. Where conflict does arise it is usually the result of inadequate enforcement of national maritime boundaries.

The allocation of resources between competing groups within one state/territory/community and one stock or group of stocks includes resolution of conflict between industrial fisheries and artisanal or small-scale fisheries as well as between recreational and commercial fishermen. In some nations these have been resolved by legislative control including partition by gear used and/or physical area demarcation by virtue of technology available to the various user groups. The optimal allocation of the resource is necessarily dependent on the specific needs of the user groups concerned and the resolution of this matter is dependent on the objectives established.

Mechanisms for allocation of the resources vary according to the situation. These range from the establishment of international fishing treaties to local legislation. In some cases conflict continues as a result of poor resolution and perception of the problem, due to a lack of appropriate information. Means of allocation include catch quotas (both total quotas and individual transferable quotas) and effort quotas.

There are considerable difficulties in applying catch quotas as an allocation mechanism to shrimp fisheries because the stocks are short-lived and subject to annual variability. The application of catch quotas to many countries with artisanal fisheries would present insurmountable problems due to the lack of data for predicting stock sizes and the enforcement requirements. The imposition of total allowable catches on short-lived species would also have the effect of concentrating the catching period to a time, usually soon after recruitment which was not necessarily the appropriate time to achieve an optimum yield.

In considering introduction of catch quota allocation mechanisms it is important to examine those situations where it has been applied in the past and draw lessons from the management problems. Quota management has been effective in managing other species in well controlled industrial fisheries where landings could be recorded and adequate communication is available. This is not possible in most small-scale or artisanal fisheries.

In many cases existing management regimes may dictate the choices available, such as in limited entry fisheries where fishermen are "locked in" and have an expectation of continued economic viability. Other problems include the impact of fishery management on adjacent fisheries, particularly where regulation of seasonal or total closures redirects fishing effort onto other resources.

In recent years in developed countries allocation of resources has involved fishermen in the process of management and allocation. This greatly improves political acceptability of what is often a difficult situation. However, this does not avoid problems associated with interacting fisheries.

The mechanism of area separation to protect inshore small-scale fisheries has met with varying success depending upon the effectiveness of enforcement. Allocation by gear restriction appears to be generally unsuccessful.

Allocation mechanisms based solely on effort quota are considered ineffective in shrimp fisheries as fishing power and time are components of effort and both would need to be controlled to produce any effort limitation.

Bio-economic modelling has been undertaken for the analysis of net economic benefits of industrial and artisanal sequential fisheries for tropical shrimps and the technique is available for application. Decision-making for allocation of shrimp resources is often undertaken implicitly, such as in cases of development of infrastructure facilities. There is a strong link between development and the allocation of resources and it is important that these are taken into account.

The implications of resource allocation using the methods described and those in operation are of a biological, social and economic nature. Changes to species and size composition of shrimps following area allocations have a measurable economical impact; however, in many cases the impact is not assessed due to the lack of an appropriate data base.

Summary

1. Allocation of prawn shrimp resources can be categorized into international, intra-national and intra- state/territory/community.

2. Competition by users for common resources presents considerable problems to both developed and developing nations in all areas under a wide variety of circumstances.

3. The introduction of extended fisheries jurisdiction under the provisions of the Law of the Sea Convention has in some cases transferred problems of resource allocation from an international to a national context.

4. Some nations are attempting to solve difficult problems of allocation by involving industry in management.

5. Other nations are approaching the conflict between small-scale and industrial fisheries by spatial allocation, although this is still presenting considerable problems in some regions.

6. Some nations are unable to identify and/or resolve resource allocation problems due to lack of a data base. Urgent attention should be given to the establishment of reliable data bases in these nations.

CONTROLS - FISHING EFFORT

Controls on fishing effort are generally implemented to improve the economic performance of the fishery, but can also be used to meet biological objectives. Basic economic objectives include the enhancement of catch per unit effort, and improvement in the yield per recruit. Increases in yield per recruit are usually achieved by use of closed areas/seasons. Containment or reduction of effort can also be used to enhance breeding stock levels in some fisheries where recruitment may be affected by exploitation. A necessary prerequisite to fishing effort control is reliable data on the levels of fishing effort. In countries where effort is measured it is usually on the basis of hours or days trawled. However, for many fisheries (particularly extensive artisanal fisheries) such data are not available and are difficult to collect because of the large numbers of vessels, fishermen and wide variety of gear used.

The degree of control on fishing effort differs widely between countries and ranges from comprehensive control utilizing limited entry policies together with seasonal closures and other measures through to no control.

Most countries are concerned by the level of fishing effort being applied to their shrimp stocks but direct effort controls are considered difficult to implement because of their political unacceptability. Significant problems may be caused by incentives such as subsidies on catch or vessels, because these may lead to increases in fishing effort at a time when fisheries agencies are expressing concern about the level of effort. Better co-ordination between development and fisheries management agencies is essential if optimal usage of resources is to be achieved.

In reducing effort a clear distinction should be made between the problems of industrial and artisanal fisheries. In industrial shrimp fisheries emphasis is on the economic benefits of reducing fishing effort (although social impacts are of importance in some areas). Methods such as self-financing buy-back schemes appear to have the best potential for reducing fishing effort and also achieving equitable compensation to those withdrawing from the fishery. A limited entry structure is necessary as a basis for fishing effort control, although limiting entry to a fishery does not in itself ensure adequate control of fishing effort. Limited entry is generally favoured by industry as it is perceived as providing existing operators with protection from further competition. The benefits of limited entry schemes (such as constraining growth in fishing pressure and identifying a group of fishermen with whom subsequent negotiations could take place) should be weighed against the fact that such schemes will not resolve over-capacity in a fishery and may restrict the ability of vessels to move between fisheries. Experience in Australia has shown that the introduction of limited entry to a fishery often results in the need to limit entry to adjacent fisheries because of the problem of transfer of effort.

In extensive small-scale fisheries the application of limited entry management is considered less appropriate, particularly in developing countries where it presents significant social and administrative problems. Compensation for removal of vessels from a fishery exists in some countries but,since such compensation schemes operate only on a limited entry context, they are not commonly used elsewhere. The problems of identification of fishermen, particularly in large artisanal fisheries, is a significant deterrent to any attempts at direct fishery effort controls. Licensing of small-scale fishermen has received attention in some areas.

Indirect methods of control of fishing effort are a realistic alternative in situations where direct methods, such as limited entry, are not feasible. These indirect methods include taxes on fishing gear, removal of subsidies on catch, vessels, fuel or fishing equipment, and provision of incentives to redirect fishing pressure. However, in all instances, close coordination between the authorities responsible for these aspects and the fisheries management authority is essential.

Any fishing effort control scheme should be sufficiently flexible to be able to respond to changes in the overall management requirements of the fishery.

Summary

1. Most countries in the Asia-Pacific region have high levels of fishing effort in their shrimp fisheries, although in many instances no specific effort control measures have been adopted.

2. In areas where no effort control measures have been introduced, direct intervention (such as limiting entry) is either politically or socially unacceptable, too expensive or administratively impractical.

3. Limited entry policies, such as those now in place in all Australian shrimp fisheries, provide a framework for effort control but result in repercussions which should be recognized before such policies are introduced elsewhere.

4. Indirect methods of effort control should be examined, although it is essential that coordination take place between the agencies responsible for development and those responsible for fisheries management agencies in order to achieve the desired results.

CONTROLS - SIZE AT CAPTURE

Two techniques are used for controlling size at capture: closures and mesh selection. Closures can be separated into two principal types - those designed to protect nursery areas and those designed to either limit fishing effort or to regulate the size at first capture of shrimp.

Nursery ground closures and habitat protection

Closures of inshore shrimp nursery areas are usually aimed at protecting the post-larvae and early juveniles of shrimp species against either fishing pressure or disturbance or destruction by man-induced effects. They can be permanent or seasonal. In such areas physical disturbance of the area by processes like land reclamation, pollution, alternative development (e.g. extensive aquaculture, fuel sources, and artisanal fisheries) are the main causes of reduction in available habitat for pre-recruit shrimp. The protection of juvenile nursery habitat is essential for the continued biological well-being of shrimp stocks but maintenance of this habitat is often not under the control of the fisheries management authority. The demands on this resource by other, often non-fishing, user groups is considerable in some nations, particularly the developing countries. The utilization of mangroves, mangrove environment, seagrasses and, for some species, bare substrate, represents a threat to wild stock resources.

In most countries steps are being taken to protect shrimp nursery areas, although in some instances such protection is a by-product of protection for inshore small-scale fishing fleets and is not specifically aimed at protection of shrimp nursery grounds. Protection of nursery areas should not be considered in isolation and complementary fishing effort controls should be considered in the overall management regime of the fishery. Excess of fishing effort could result in encroachment of the inshore closed area by trawlers. In some instances weather conditions (e.g. monsoons) result in natural closures of inshore areas for at least part of the year.

Seasonal fishing ground closures

Closure of fishing grounds to exploitation for a period of time is usually carried out with the aim of maximizing the yield or value per recruit or of reducing fishing effort levels.

In Australia pre-season surveys provide useful predictions of the optimum time for opening the fishing season within a small area, although more extensive information on recruitment by area is needed if predictions are to be useful over a wider area. The cost benefit ratios are generally favourable and in the case of the Australian Northern Prawn Fishery the benefit is estimated to be about 14 times the cost. Accurate information on growth rates and natural mortality rates is necessary for predictions to be reliable and the estimation of the size at which maximum biomass occurs is particularly

sensitive to values of natural mortality (Fig. 1). There are practical disadvantages to closures which regulate the size of first capture. For example, high levels of fishing effort occur immediately after the opening of the season (target fishing). The presence of more than one species in the catch may make it impractical to optimize the yield or value per recruit of all species comprising the fishery. There is a need to consider economic and social effects of closures in addition to biological aspects.

In most cases the use of fishing ground closures for reducing fishing pressure on some parts of the population results in an initial increase in fishing effort as operators seek to take maximum advantage of the limited time available for fishing. As a result, additional controls are usually necessary to take account of the interaction between closures, fishing effort levels and size at first capture.

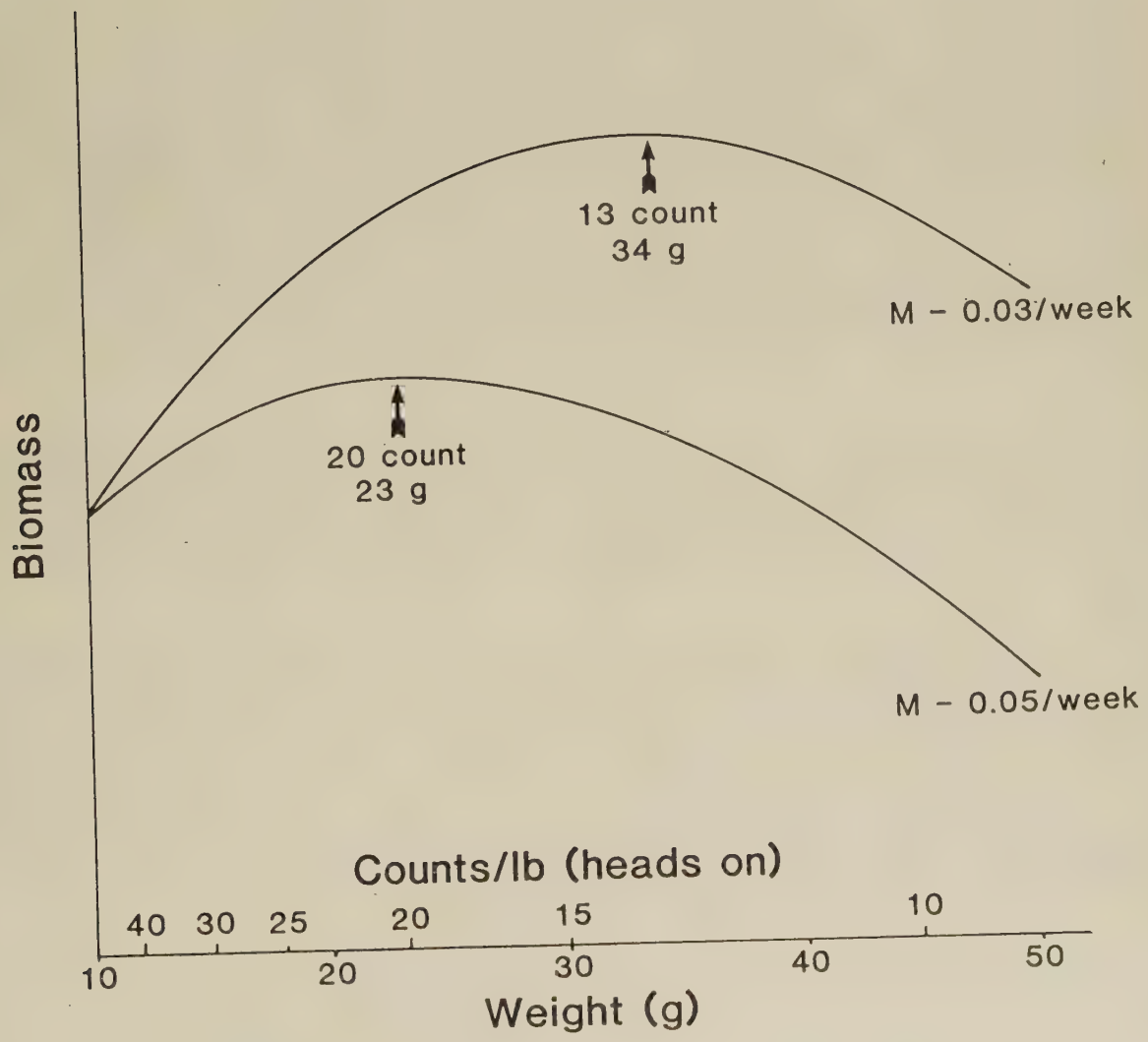

Figure 1. Weight of shrimps in relation to biomass with different estimates of natural mortality

Seasonal closures are also of use in regulating the abundance of the spawning stock. Protection of juvenile stocks is a more effective technique for regulating the numbers of spawners, but spawners may still need to be protected from fishing during the major spawning period if fishing pressure is heavy. While closures are considered to be an important and effective management tool in some developed countries, serious practical problems limit their usefulness in certain developing countries. These problems include severe social and economic disruption to artisanal fishermen which might result from a seasonal closure, the multispecies nature of many fisheries, the large size of fleets and their dispersion. A lack of commitment to enforcement, an absence of data on population parameters and information on fishing effort and distribution make the establishment of closures on biological grounds difficult.

The objectives of management in developing countries are not always related to purely economic goals, and therefore the use of closures to achieve maximum economic benefit to the industry might be inappropriate.

Involvement of industry is an essential ingredient both in setting management objectives and in establishing appropriate methods of achieving those objectives.

Mesh selection

Although the imposition of mesh size regulations is sometimes viewed as the only practical alternative to regulation by minimum size legislation, it is the experience of most countries that the size of shrimp caught is not well related to mesh size. Other factors, such as the way in which the trawl net is rigged and operated, appear to have a significant effect on selection sizes and should be considered in any mesh size experiments or regulations. However, in some instances, mesh size regulations may have value in avoiding interactions with other species, such as allowing the juveniles of commercially valuable fish species to escape. Sometimes where shrimp occur on grounds used by alternative fisheries (e.g. scallops), the mesh may be made large enough to allow escape of shrimp. In heavily exploited fisheries mesh size regulations alone will not solve the overfishing problem and regulation of overall effort levels has to be considered.

Enforcement

In addition to the problems created by the dispersion of traditional fleets, the major obstacle to adequate enforcement in developing countries is that the need for enforcement is often not accepted at a political or an industrial level. In Australia industry involvement is necessary for enforcement to be fully effective. Self-enforcement by industry increases the effectiveness and decreases the cost of enforcement.

Summary

1. There is a need for protection of nursery areas and most countries have introduced or are in the process of adopting inshore closures. Conflicting uses of these areas should be carefully examined.

2. In some fisheries the use of seasonal closures of fishing grounds to regulate the size of first capture of the shrimp is practicable over at least small areas and provides favourable cost-benefit ratios. However, data requirements as well as the socio-economic considerations make the application of such techniques impracticable in many developing countries or in complicated extensive fisheries.

3. Closures cannot be considered in isolation as a management tool and the interrelationship between size at first capture, effort levels and closures in regulating annual production should be considered in any management plan.

4. Mesh size restrictions have not been successful in controlling size of shrimp captured, although they may be useful in some mixed fisheries (e.g. shrimp and scallop).

DATA COLLECTION

The necessity for information as a basis for the sound management of shrimp fisheries is universally recognized. It also is obvious that when management involvement increases more detailed information is required to support the management scheme.

Three basic types of information are required for fisheries management:

- Operational information: these data are required to support the more intensively managed fisheries and are required in real time (on a day-to-day basis).

- Management information: these data are used, for example, to make decisions on closures, control of effort and to assess the impact of management options. These data are usually required within a few months after collection.

- Research information: information used to monitor trends within the fishery, and make detailed biological and economical analyses which are an integral part of the management scheme.

These three broad categories of information can be used to provide a general description of the fishery and the people involved. Other basic information includes an understanding of the dynamics of the stocks, their distribution, structure of the fleet and the level of catch in relation to historical activities. This information is also useful in understanding the marketing structure and forces involved in the fishery and to assess the fishery's economic health. Even though there is a need for a wide range of data, some information cannot be readily obtained. For example, separate research efforts are required to obtain socio-economic information and data leading to the estimation of biological parameters.

Anticipation of future information needs and their incorporation into the collection of data would help ensure that when problems arise essential information will already be available. Sufficient knowledge now exists to be able to identify future problem areas. It should, therefore, be possible to avoid situations whereby data collection is initiated only in response to a problem.

It appears that the amount of data currently collected in many countries reflects the level of uncertainty acceptable in their management. Highly regulated fisheries, in which the least amount of uncertainty is acceptable, have the greatest requirement for accurate data. Excessive collection of data should be avoided as it creates an unnecessary burden and will possibly affect the quality of information supplied. Stratified sampling is an important aid to the collection of data, especially for artisanal fisheries.

Developing countries in the Asia-Pacific region could use a fishery census to make an inventory of their fisheries in terms of numbers of fishermen households, number of vessels and gear by type. Catch assessments, socio-economic and other surveys are needed in addition to fully described fisheries. Although some form of catch and effort information is being collected in most countries, few undertake socio-economic surveys. Data to allow standardization of fishing power and shrimp size grade data should also be collected.

The most detailed coverage of data comes from small industrial fishing fleets. Where larger fleets are involved, adequate data are obtained only in the more valuable fisheries. Very little information is available for artisanal fisheries.

When little information is available, the use of proxy variables and the identification of relevant collections of data by other organizations can be of great assistance. Information on fuel usage, ice production, licensing statistics and anecdotal information can all be of assistance, particularly where it relates to changes in fishing patterns. Frequently only gross annual data are available; these may be limited to exports and may exclude consumption within the artisanal sector.

Great care is necessary in interpreting historic collections of statistics because of changes in fishing patterns. A change in catch can be due to a number of factors, many of which may not have been documented.

Ideally, data should be collected by each user group. This has the advantage that data is collected to meet a specific purpose resulting in improved quality control. The major disadvantage of this approach includes possible duplication of data, incompatibility between collections, and the difficulty of maintaining the collection over a long period of time or over a large fishery.

Collection of data by a centralized group has the following advantages:

- leads to a more standardized system with more comparable data;
- minimizes the investment required in computer systems and development;
- data collection is more likely to be available over a long-time frame;
- outside users can be more readily accommodated, as the system can be designed to be flexible.

The main disadvantage of a centralized system is that quality of data may be reduced due to lack of involvement and understanding of the fishery. In addition, the more centralized the system, the longer the time lag in providing information to users.

Collection of detailed information requires the cooperation of fishermen in order to prevent escalation in cost of data acquisition. In those fisheries where sufficient background biological information is available, one direct benefit to fishermen is the maximization of catch value through appropriate timing of fishing.

Data collection should be approached on two levels. Detailed information for long-term research should be carried out on selected fisheries while more broadly-based data should be collected for general management purposes.

Collection of data is not difficult in the smaller industrial fisheries. In artisanal fisheries, however, considerable difficulties are encountered because of:

- the numbers of fishermen involved;
- the many possible landing points;
- poor educational level of fishermen;
- lack of trained data collectors.

The main solution to this problem is the use of regular census to survey the fishery, with particular attention being paid to the framework of the survey.

In most countries, some form of a log book or interview system is being applied in the industrial fisheries, while research vessel data is also available in a few countries. Surveys of artisanal fisheries are being carried out in many countries and, where fish are auctioned at a market place, data is more easily collected. Due to the changeable nature of fisheries, there is a need for regular updating of the frame survey findings.

The value of information is often not properly demonstrated to the decision-makers who control the funding of its collection. Availability of reliable data about the fishery is recognized as essential by all those involved in management, but if this need is not demonstrated to the executive, adequate manpower and funds may be lacking. This in turn results in inadequate coverage and poorly motivated staff.

Support by fishermen is essential to ensure that good data is supplied. The more involved fishermen become, and the more they can be assured that the data they are providing is being used as a basis for decision-making, the greater the likelihood that they will give more accurate and detailed data. The information and its application needs to be made understandable to and usable by industry. Opportunities for industry's comments need to be sought so that scientists, administrators and fishermen have similar appreciation of how the data are used. Fishermen should be assured about confidentiality of data. Information is valuable and, if the fisherman's concern for secrecy about his data is not respected, less reliable data will be supplied.

The major tools available for cross-checking and validation of data are:

- use of observers who can provide some verification of data;
- use of landing and processing figures as well as marketing or auction data to provide total catch figures;
- anecdotal checking by the collectors of data through close liaison with the local fishing community;
- independent surveillance by aircraft.

The local situation in a developing country should be taken into consideration when choosing methods of collecting data. Highly precise data is often out of reach and in some cases not needed. Problems encountered in data collection in these countries can stem from lack of support for the data collection staff and lack of analyses of the data collected.

Summary

1. Management of shrimp fisheries requires a wide range of information at various levels of detail ranging from real time data to periodic frame surveys.

2. In general, the resolution of the data should be appropriate to the degree of sophistication of the management. More detailed information may have to be collected on selected fisheries for continuing research.

3. Anticipation of future needs should be incorporated into the collection of data and the possibility of future changes in management objectives should be recognized.

4. Collection of data should ideally be under the control of the user to ensure reliability.

5. Liaison with industry to demonstrate the usefulness of the data is essential, and education on use of the data in all sections of the industry should be actively encouraged.

ECONOMICS AND TRADE

Economics

A recommendation of the FAO World Conference on Fisheries Management and Development was that, where possible, property rights should be allocated to fishermen. Establishment of property rights and permitting them to be fairly freely traded should reduce the amount of direct regulation required.

Since national shrimp fisheries cannot individually affect the world price for shrimp, the principal area for resolving uneconomic conditions is confined to adjustments in total revenues through controlling effort, improving the value of the catch (quality improvements, increase in size of shrimp) and reducing costs.

The main cost components of industrial shrimp fishing are fuel, wages, repairs and maintenance of vessels. The average fuel cost in one national shrimp fishery was given to be about 45 percent of a vessel's total variable cost, considerably higher than in other food-producing sectors. Because of this, attention needs to be directed towards reducing fuel costs for fishing fleets as a means to lower costs. This can be primarily achieved through management to reduce fishing time and improve catch rates. Since redirection of fishing time can result in improvement in sizes and market value of shrimp captured, management can have a considerable impact in improving economic conditions in a fishery. In many shrimp fisheries management actions could be considered as the principal thrust for further development of the sector.

The distribution of income in certain shrimp fisheries shows that a substantial proportion of fishermen operate with negative economic returns. This proportion is highly sensitive to price changes in the shrimp market. Ways of improving conditions in shrimp

fisheries, particularly the role of technical innovation in harvesting, need to be investigated. While innovations contribute to the competitive ability of individual vessels, they are rapidly adopted by the remainder of the fleet and eventually the individuals within a fleet are no more competitive than before the innovation. Certain constraints on innovation and technical change may be necessary as part of a management plan. Alternatively, increases in efficiency in fully exploited fisheries require compensating management measures in order to reduce fishing effort and contain costs. This can be achieved firstly through imposing limits on fleet size and secondly through reducing numbers of vessels and/or fishing time.

Measures such as licence control and fleet reduction are particularly relevant to industrial shrimp fisheries because of variability in shrimp stocks, particularly when heavily exploited.

Methods of determining the economic consequences of management actions are necessary. Input/output models and linear programming techniques are particularly valuable in determining options for formulating fisheries objectives. A model for determining the appropriate economic allocation of shrimp between an industrial and artisanal fishery, as well as for determining the optimum number of licences which should be issued for foreign fishing, has been developed.

Summary

1. Because of the finite nature of the world's shrimp resources, fishing effort will have to be controlled. If this does not happen, fishing resources will decline and fisheries will be characterized by a surplus of vessels and chronic low income problems among fishermen.

2. Establishment of individual property rights can be an important component of a management plan.

3. Profitability of shrimp fisheries is very sensitive to fuel costs and shrimp prices.

4. Reduction of effort and improvement of value of the catch are the most effective ways of improving economic viability.

Trade

The world trade situation for shrimp consists of many producers supplying two principal markets, Japan and the USA. The USA is the largest importer of shrimps and demand is believed to be a function of disposable personal income. Demand in Japan is considered to be influenced by the price of substitute products, such as beef and chicken. Interaction between the United States and Japanese markets is a function of the relative value of the two currencies.

The Asia-Pacific region is a major supplier to both markets as well as the EEC. Most estimates for future demand in these markets were considered to be favourable for the region, particularly since world supplies from capture fisheries could not be expected to increase significantly because of the finite limits of the resource.

Increase in production of shrimp from aquaculture is starting to affect the price for small shrimps from the capture fishery. There are conflicting opinions as to whether increases in the supply of shrimp from aquaculture will negatively affect the price of large shrimp from capture fisheries. One study suggests that, provided that projections indicating improved demand in the future were correct, even moderate increases will not affect prices. Another study has projected that future competition from aquaculture will decrease prices significantly. With existing aquaculture techniques the increased costs, especially of food, associated with production of larger sized shrimps might alleviate direct competition with shrimp from capture fisheries. The dependence of aquaculture on wild shrimp postlarvae is a constraining factor. Future expansion in supplies from aquaculture will be dependent on the successful production of larvae from hatcheries, improvements in technology and decreases in the cost of foods.

There is a large degree of interdependence in shrimp trade between countries in the Asia and Pacific regions. Australia, for example, exports large shrimp to the USA and Japan and imports considerable quantities of smaller shrimp from Asia for its domestic consumption.

The value-added component of exports of shrimp could be used to raise value of landings. Significant employment benefits exist in the onshore processing sectors and improvements in exports could have a significant impact.

Although quality control is a serious problem for many nations in the Asia/Pacific region, the situation is improving. Government inspection services should result in significant gains in quality. These services are particularly important for small producers who are unable to support a quality control programme.

Summary

1. The two major markets for shrimp are Japan and the USA.

2. Demand for shrimp is likely to increase faster than supply over the next few years, particularly for the larger sizes.

3. Supply of small shrimp from the aquaculture sector will become increasingly important but it is not known whether this increase will greatly depress world shrimp prices.

APPENDIX 1

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